Electrical Transport Measurements with Atomically Precise Probes

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A major challenge in the development of novel devices in nano- and molecular electronics is their interconnection with larger scaled electrical circuits. Local electrical probing by multiple probes with precision on the atomic scale can significantly improve efficiency in analyzing electrical properties of individual structures on the nano-scale without the need of a full electrical integration.

The LT NANOPROBE is a sophisticated instrument that merges the requirements of a 4-probe system, efficiently and precisely navigated by a scanning electron microscope (SEM) and at the same time satisfies the needs for high performance SPM. The excellent stability in the pm range allows for atomic resolution in STM and nc-AFM (QPlus) and expands applications from electrical probing on the nanometer scale towards tunneling and force spectroscopy and the creation of atomically precise structures. The system is operated near thermal equilibrium and temperatures below 5K, specifically also during simultaneous SEM imaging and navigation. The system has been developed towards an extremely low thermal drift in the range of 100pm/h, which is the most important ingredient to allow for enough measurement time on extremely small structures.

We will present measurements that prove the performance level of the instrument, specifically the low thermal drift and stability as well as QPlus AFM measurements, which become important if nanostructures are deposited on an insulating substrate for a better electrical decoupling. We will also show the newest technology improvements, such as high frequency capabilities and optical access for pumped probe experiment. Future technology challenges as well as applications and scientific drivers for this type of scientific instrumentation will be discussed.

Figures

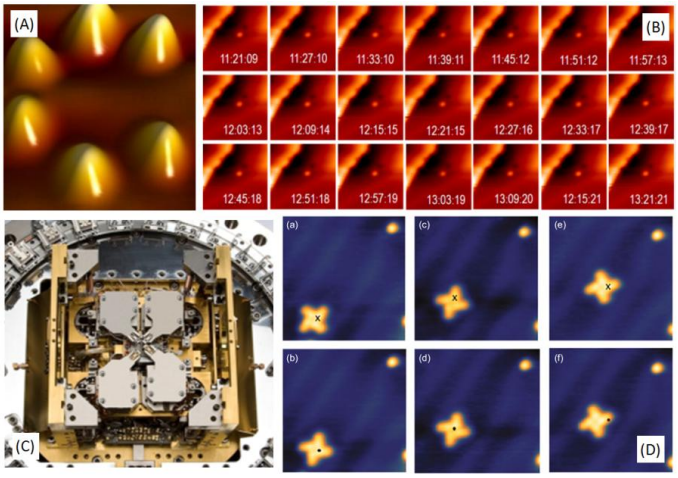

Figure 1. a)STM atom manipulation on Au(111) @ T<5K. Data Courtesy by Ch. Joachim et al., PicoLab, CNRS, France b)Drift measurements STM on Au(111) @ T<5K. Image size 20 nm2 , Ugap = 0.5 V, IT = 0.5 nA. Total measurement time of approx. 2hrs, resulting in a lateral drift < 1.3Å/h. c)Picture of the LT NANOPROBE stage, showing thermal shields, spring suspension, and 4 dedicated shared stack SPM scanners. d)STM manipulation of acetylbiphenyl (ABP) molecules on the Au(111) surface @ T<5K. Data Courtesy by F. Eisenhut et.al. ; Eur. Phys. J. Appl. Phys. (2016) 76.